

# Towards a Model Based Electronic Nursing Record

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## Abstract

*The electronic nursing record (ENR) as part of the larger electronic health record has been discussed for years. Its implementation is not that widespread as often considered. E.g. in the Netherlands, a fraction of hospitals uses it. This paper describes a nurse led project in a Dutch hospital where an electronic nursing record system has been defined, based on requirements analysis, standardization through Detail Clinical Models (DCM), and implementation. Standardization of data with DCM is a method and a format to organize clinical knowledge, concepts, and data elements such that managing and exchanging semantics of data is independent from specific technology. 28 DCM are used in the specifications of the ENR. Using the DCM standards approach and the mapping of data elements to professional terminologies enable a vendor to develop what is needed for quality care, rather than sell a fixed set product.*

**Keywords:** detail clinical models, DCM, electronic nursing record, nursing informatics, patient data, classifications

## 1. Introduction

The Onze Lieve Vrouwe Gasthuis (OLVG), a top clinical hospital in Amsterdam, the Netherlands, decided to standardize the patient data with Detail Clinical Models (DCM), including mapping data elements with multiple nursing classifications with the goal to achieve an Electronic Nursing Record (ENR). The project includes a short term ENR solution with limited functions, using standardized generic forms, and a proper nursing record specification for a future long term solution, to be integrated in a multidisciplinary Electronic Health Record (EHR).

The generic patient data are determined after an inventory and an analysis of the current nursing paper record forms on all nursing wards. Further, the method for the standardization has been determined. From the onset, the goal was to have a short term ENR and a long term EHR, hence, the specifications should be useful in different technologies. For this, the standardization approach with DCM was chosen, and approved by the hospital board<sup>1</sup>. OLVG is the first hospital in the Netherlands using the DCM method for determining nursing data. In addition, where other EHR projects often use one terminological system only, this project uses multiple terminologies. In the context of the national infrastructure for IT in the Netherlands it has been identified that preciseness of coding requires the use of multiple terminologies.

The overall project for the ENR and specification for the nursing content of the EHR started end 2010 and is based on the following assumptions:

- Generic patient data (relevant to nursing care for all medical specialties) are standardized with DCM. This implies reference to the nursing knowledge base, defining the meaning of concepts and symbols used, and detailed specification of data elements. Purpose of DCM is establishing a unified conceptual basis in nursing information management, and care processes. This facilitates the proper interpretation and use of nursing data. With DCM, data are defined structurally, and each data element is mapped to a unique concept and code from one of the standardized nursing terminologies and classifications (e.g., SNOMED CT, ICF, ICNP, NIC, NOC, ICD10, LOINC). In addition, where possible, UCUM units are specified.
- For the short term ENR solution, the generic forms such as patients identification and administrative data, nursing assessments, vital signs, fluid balance, and quality indicators such as pain scales, pressure ulcer instruments, and SNAQ are created based on the DCM standardized data, mapped with SNOMED CT, LOINC, or other coding systems and implemented in the ENR system.
- The project has a bottom up approach, with informatics nurses carrying out the major tasks such as the inventory, analysis, standardization, determination of ENR requirements and testing the forms and system functions.

- Putting the nursing profession in control of composing the content of the DCM, specifies the professional content for the ENR to the vendor. The professional knowledge is better maintainable this way, because it is not locked in a vendor specific system.

The purpose of this paper is to report an approach in which a proper information analysis is carried out, the standardization of nursing data with DCM is used, in order to develop an ENR. One question is whether it is possible to see if, and if yes how, the standards based DCM approach is suitable for the daily practice of nursing care in the OLVG and whether the nurses in the project team are able to contribute to DCM development.

## 2. Background

### Onze Lieve Vrouwe Gasthuis (OLVG)

The OLVG is a large top clinical hospital in the heart of Amsterdam. The hospital combines quality care with a high degree of hospitality. The OLVG is a Teaching Hospital with a large offering of medical specialists, nursing and paramedic care and education. Further, the hospital initiates applied patient related research in cooperation with the Amsterdam Medical Center University Hospital. The annual number of outpatient visits is over 290.000. Day care is offered to 13.000 patients and clinical admissions are over 19.000 per year. Being an inner city hospital, the patient demographics are quite diverse. The OLVG is leading in the areas of Cardiology, Cardio-thoracic surgery, Intervention cardiology, HIV-treatment centre, Level III Intensive Care, including tele-IC facilities and Emergency Department with 54.000 annual visits. The OLVG has 555 beds, ca. 3300 employees of whom 180 medical specialists and 900 (specialized) nurses and nurse practitioners.

### DCM

DCM is both a method and a format to organize clinical knowledge, represent concepts, and define data elements in such a manner that it allows managing and exchanging semantics without the need to use a specific technology. DCM represent semantics of clinical concepts (data) via linkages to standard terminologies and codes in a technology independent way. Because DCM deal with the conceptual level, with some logical model to represent it, there is always a transformation necessary to the implementation level. This is using DCM in a Model Driven Architecture (MDA) approach<sup>2</sup>. This makes it feasible that EHR / ENR can be developed, and interact with existing healthcare information technology. One implementation is the ENR database for which a conceptual models is uses (Figure 1).

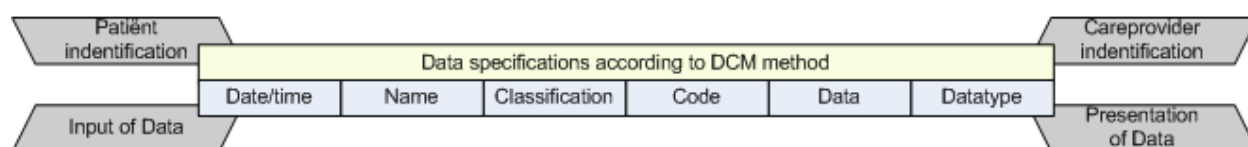


Figure 1 Data element specification in DCM (core part) and EHR system (4 corners), as database design.

### EHR in the OLVG

Currently the OLVG has the ambition to implement a modern EHR system of the fourth generation. Intensive care unit, Anesthesia, and Emergency Department are using a Patient Data Management System. For the ENR project, in 2010, the nurses carried out a complete inventory of available forms and documentation methods on 15 general wards. All distinct data were entered into an Excel spreadsheet, sorted, compared, and analyzed accordingly. The results from this inventory and analysis show the following (Table 1)<sup>3</sup>.

Based on these results of the information analysis, the conclusion is a large diversity in forms, data entry methods and places and duplication of data. Different forms often include the same data. There is no accepted terminology or data representation, hence information is defined in different ways. Forms for the same clinical purpose have different names. Forms are often used retrospectively as a checklist or control mechanism. The record consists largely of a set of checklists developed on decentralized level and used to control the work of doctor and nurse.

<b>Table 1. Used nursing data in OLVG:</b>	
5500 records with distinct patient data	Total of 315 unique forms with patient data;
169 entries where the patient name is documented. Median 9 times per record;	33 entries for the unique patient identification;
57 markings of allergies (1/6 of all forms);	23 different forms for the fluid balance, all with different terms used;
41 unique forms for the vital signs (blood pressure, pulse, weight etc.), on average 2,5 forms per ward;	5 forms per patient record, one for each quality indicator.

### 3. Methods

In November 2010, the ENR project started with a group of nurses and informatics nurses with a first step: sorting out the data in the Excel spreadsheet in logical groupings (Table 1). Next, the data were mapped into consistent categories of generic patient data. Of these categories, five were selected to start with in small groups, including Measurements, Fluid Balance, Nursing Assessment, Administrative patient data, and Quality Indicators.

In a 2<sup>nd</sup> step, three groups of each five nurses, supported by two project leaders and the external expert, applied the DCM methodology in which the evidence base for concepts was explored and summarized.

The data elements were specified, and meta-information on authorship, version control and publication dates were added. This work started with educational sessions, with support available. For this work a Word template (evidence base) and Excel template (data specification and coding) were applied, carefully following existing DCM examples, developed for the national infrastructure for information technology in the Netherlands.

The OLVG templates are a variation on the national guidelines for DCM<sup>4</sup>, in order to allow the practicing nurses to complete the relevant section. Then the project team encoded the data with technical specifications of the data elements. Overall, all required DCM parts are included.

The nurses reviewed existing DCM from the national DCM repository<sup>5</sup> for relevance for the OLVG ENR project, selected the required ones and adapted these for practical use where necessary. Where possible, the groups requested in-company support from experts, e.g. for pressure ulcer prevention and care. When a group had finished their DCM, the results were presented to the whole project team and reviewed. To support cooperation, an online project site was established by the project leaders, where all documents could be stored and accessed by each group member. Strict version control was established to prevent duplication and loss of specifications.

After the project team as a whole approved the DCM, the next step was the unique coding of each data element in the DCM by the informatics nurses. Where required, the informatics nurses added the meta-information and technical descriptions as well. They used a pragmatic approach: only those data elements that will be used in the first stage of the ENR project were coded now. The next step in DCM creation, verification, and coding includes a second verification round within the OLVG medical and paramedical professions. The final step is the actual functional design and the system implementation. In some instances, the creation of functional design and/or implementation generated new questions. The DCM groups addressed these.

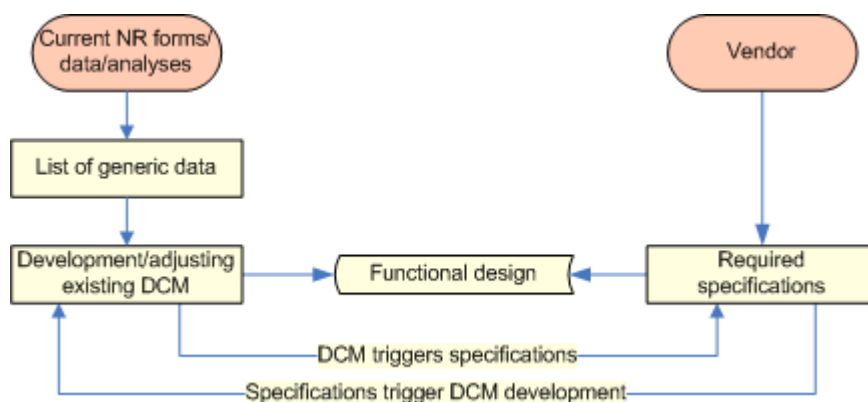


Figure 2. DCM review and development process.

## 4. Results

### DCM

The group in the ENR project realized during biweekly meetings of 2 hours in a 6 months period a total of 28 DCM's, of which 9 where localizations from the national repository, and 19 where developed either from scratch, or completed existing unfinished draft materials. The expectation is that after their validation in the ENR a collection will be contributed to the national repository. Large parts of the data elements and value sets in these 28 DCM's where coded with Snomed CT or LOINC codes. However, data elements not used in the ENR implementation were not coded due to time and cost considerations: specify only what is actually going to be used in the ENR.

Table 1: DCM's adapted (A), completed (C) or developed (D) in the first semester of 2011		
Breathing (C)	Weight (A)	Pupil reaction (C)
Nursing assessment (at admission) (D)	Heart frequency (A)	Oxygen Saturation (C)
Blood pressure (A)	Length (A)	Tube feeding / products (D)
Decubitus risk score (C)	Long excretion (D)	Temperature (A)
Decubitus wound due to moisture (D)	Stomach excretion (D)	Fluids in (D)
Decubitus wound classification (C)	Urination (C)	Fluids out (D)
Defecation (C)	Patient administrative data (A)	Fluid balance (D)
Delirium (C)	Person data (A)	Care Professional data (A)
Glasgow Coma Scale (A)	Pain score (C)	Oxygen administration (D)

The DCM Word template allowed the nurses to complete the content and they used the Excel spreadsheet to list the data elements. Next, the informatics nurses and external expert completed the technical specification, unique coding, and meta-information. DCM are then placed in the hospitals document management system, allowing governance in the hospitals quality system. The plan is to have each DCM reviewed every two years by the original authors. DCM are linked to the ENR specifications.

### DCM in the ENR

DCM's have been applied in the functional design of the ENR. The vendor programs the data in the ENR. In the ENR the data entered are stored with the matching codes, times, and patient identification data and care provider data (Figure 1). Expanding, or changing the data specification in the ENR, such as adding the option to include body position to the systolic and diastolic data is easily done via configuration of the table. This is carried out via storing the code and adding the required field to the data entry screen of the ENR (Figure 3). In the functional requirements for the future long term solution, where the ENR will be integrated in a multidisciplinary Electronic Health Record (EHR), the requirement to deploy the full DCMs is considered mandatory.

Figure 3 A screen example of the section for measures, all based on DCM specifications (In Dutch, Top: date / time / professional, Middle: vitals, heart frequency, regularity, body location, blood pressure (Systolic & Diastolic), body location, invasive/non invasive).

## Profession/organization

In 2010 the ENR project was established with 2.3 FTE informatics nurses team. Two nurses are completing their informatics nurse degrees. In addition, 20 nurses and advance nurse practitioners participate in DCM development. This group has gained sufficient knowledge and experience to continue this methodology in the future. The chief medical information officer is advised to submit the relevant DCM for verification of the content for medical use in addition to nursing use of similar data in the DCM. Another interesting effect of the project is that to complete the section on instructions in the DCM, existing practices, guidelines and protocols are reviewed, or new are created. This will be submitted for approval to the hospitals Nursing Board, and Quality committees respectively.

## 5. Discussion and conclusion

It took quite some time for the nurses to start with the creation of DCM and the methodology behind it. Several sessions were needed for education and encouragement. However, gradually the first DCM were ready and discussed in the whole team, informing and stimulating the other team members. Searching for all the background knowledge remains a time consuming effort. Other projects use a DCM Unified Modeling Language format,<sup>4</sup> however, that was found too ambitious for this project. Hence a split into two templates, a Word template for the nursing content and an Excel template for the data element specification, allowed the nurses to concentrate on the professional content. Later, the informatics nurses and external expert completed the technical parts and coding of data elements and value sets. DCM typically specify a maximum dataset: everything that belongs to the concept is written out and each contributing data element is included.

DCM format misses standard naming of classes and a color representation of data, this will be added in future style guides. However, for implementation, especially if it is for a two-phase development like with the ENR, and a future EHR, several data elements will not be implemented in the first stage. The DCM format is in fact an mechanism to justify which parts are implemented, and which are considered, but not implemented yet. Criteria to choose some data elements from the DCM above others are relevance, time and budget.

Standardizing patient data via DCM methodology proves a constructive way for both the professional content and the information technology specification. It creates an unified data specification and language, and via the coding from multiple terminologies, the resulting DCM are widely usable in the OLVG ENR and future EHR. In contrast to one expectation, it proved possible to specify, in a relative short time, a large set of generic applicable DCM. At the time of writing, several DCM are implemented in the ENR for the OLVG. The project gained from external expertise for the standardization of nursing documentation.

Some advantages of the DCM approach for the OLVG are:

Reusability of nursing data is guaranteed due to the unified data and terminologies. DCM development generates additional protocols and work instructions, which would have a positive effect to improve quality through minimizing unnecessary variations. Further, it allows the nursing profession to be in control of composing the content of the DCM, determining the specifications for the ENR, and organizing professional information management. Another positive effect is that it helps in the discussions with the vendor: requirements are highly precise and well specified, making the programming task easier. The bottom up approach to DCM standardization increased the support and acceptance among nurses. The ENR is recognized as a professional content based system, and not something imposed by some vendor. In addition, the quality indicators that are standardized via DCM support the registration of data at the point of care, which is a huge efficiency generating approach. The quality of the data collection can improve with the ENR solution and will facilitate clinical research by nurses. Finally, the DCM can be used by other disciplines as well, thus allowing potential for better cooperation.

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